DEVELOPMENT OF 2-AXIS SOLAR PANEL FOR SOIL MOISTURE DETECTOR AT 4 SEASONS COUNTRIES

MOHD FADZIL BIN MAT ISA

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Faculty of Electrical & Electronics Engineering
Universiti Malaysia Pahang

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Signature : ______________________________

Author : MOHD FADZIL BIN MAT ISA

Date :

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ABSTRACT

Photovoltaic (PV), is a technology in which light is converted into electrical power. One of the applications of PV is in solar tracker. Commercially, single-axis and two axis tracking mechanisms are available. Usually, the single axis tracker follows the Sun’s East-West movement, while the two-axis tracker follows the Sun’s changing altitude angle. To control the two axis solar panel so that it will always face the sun, the circuit will be programmed with 4 Light Dependent Resistor (LDR) as an input and 2 motor as an output. Both motor will be moved East-West and rotate around until both pair of LDR get the same percent of sunlight. It will move along the day follow to the sun. When the solar panel face directly to the sun and has maximum concentrated sunlight to the solar panel, the maximum power output will produce. The two axis solar tracker is design as active tracker and to make sure it can be used as a power supply especially in 4 seasons countries because in 4 seasons countries the sun rise and set in different angle for every seasons. It moves according to the sun movement and controlled by microcontroller. Besides that, solar tracker used to make sure have enough demand electricity, if not more photovoltaic module is needed where it is really expensive.

ABSTRAK

Fotovolta (PV), adalah teknologi dimana cahaya ditukarkan kepada tenaga elektrik. Salah-satu daripada aplikasi PV adalah pengesan suria. Secara komersialnya, satu-paksi dan dua-paksi mekanisme pengesan boleh didapati. Biasanya pengesan satu-paksi mengikut pergerakan Timur-Barat matahari, manakala pengesan dua-paksi mengikut perubahan sudut altitude matahari. Untuk mengawal pengesan dua-paksi supaya ia akan sentiasa menghadap matahari, litar akan diprogramkan dengan 4 Perintang Bergantung Cahaya (LDR) sebagai masukan dan 2 motor sebagai keluaran. Kedua-dua motor akan bergerak Timur-Barat dan pusingan keliling sehingga kedua-dua pasang LDR mendapat peratus cahaya matahari yang sama. Ia akan bergerak sepanjang hari mengikut matahari. Apabila panel suria menghadap tepat kea rah matahari dan mempunyai penumpuan yang maksimum kepada panel suria, kuasa keluaran maksimum akan dihasilkan. Pengesan suria dua-paksi direka sebagai pengesan aktif dan untuk memastikan ianya boleh digunakan sebagai bekalan kuasa terutamanya di Negara 4 musim kerana di Negara 4 musim matahari terbit dan terbenam pada paksi yang berbeza setiap musim. Ianya bergerak berdasarkan pergerakan matahari dan dikawal oleh pengawal mikro. Selain itu, pengesan suria digunakan untuk memastikan mempunyai permintaan elektrik yang cukup, jika tidak lebih banyak modul fotovolta diperlukan dimana ianya terlalu mahal.

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CHAPTER1

INTRODUCTION

1.1 Background

This chapter explains the overview on 2-axis solar tracker and the significance of solar tracker. This overview will be briefly explains on what is the solar tracker and the functions of this solar tracker. It also explains on the significance of solar tracker for the user and why the solar tracker invented.

1.2 Overview of 2-Axis Solar Tracker

Solar panel or also known as photovoltaic module is a most effective thing of way to produce the electricity. Extracting useable electricity from the sun was made possible by the discovery of the photoelectric mechanism and subsequent development of the solar cell (a semiconductive material that converts visible light into a direct current). By using solar arrays, a series of solar cells electrically connected, a DC voltage is generated which can be physically used on a load. Solar arrays or panels are being used increasingly as efficiencies reach higher levels, and are especially popular in remote areas where placement of electricity lines is not economically viable.

A solar collector or photo-voltaic module receives the maximum solar-radiation when the Sun rays strike it at right angles. Tilting it from being perpendicular to the Sun will result in less solar energy collection by the collector or the module. Therefore, the optimal tilt angle for a solar energy system depends on both the site latitude and the application for which it is to be used. With a peak laboratory efficiency of 32% and average efficiency of 15-20%[1-4], it is necessary to recover as much energy as possible from a solar power system. From this background, we see the need to maintain the maximum power output from the panel by maintaining an angle of incidence as close to 0° as possible. By tilting the solar panel to continuously face the sun, this can be achieved. This process of sensing and following the position of the sun is known as Solar Tracking. It was resolved that real-time tracking would be necessary to follow the sun effectively, so that no external data would be required in operation. The 2-axis solar panel is very efficiency used in 4 seasons countries because in 4 seasons countries the sun rise and set in different angle for every seasons.

1.3 Problem Statement

In 4 seasons countries, the sun rise and set in different angle for every seasons. So, it's difficult to get the high voltage from the sun light when we used solar energy as our supply. If we used a fixed solar panel, it cannot received maximum voltage when solar panel collect the solar radiation and number of solar cells required on a fixed flat panel to get the higher voltage. Other than that, by using fixed solar panel, the size of such a system can be unusable requiring heavy structural frames and supports to provide adequate load carrying capabilities in view of the weight such units as well as wind and snow load.

1.4 Objective

This project aim is to developed portable dynamic solar tracking system and provides the maximum voltage from this 2 axis solar panel. It will be done by using software or programming where this programming will be control the movement of motor while LDR as the input. This maximum voltage that provide from solar panel will be charged the 12V battery through charging circuit.

For the second objective of this project, it is to measure soil moisture by using soil moisture detector system. This is only additional application of this project and it just want to see whether the solar can produce a maximum voltage for used in that application.

1.5 Scope Of Project

To developed solar panel with:-

i. Move it in 2-axis.
ii. Can get higher voltage from the sun light.

iii. It will be able charge the battery with 12V DC.

Utilize solar energy to powered soiled system and to detect soil moisture for different type of soil condition, (dry, balanced, wet).

1.6 Thesis Outline

Chapter 1 is discussing about overview on solar tracker. It explain about the problem statement, objective and scope of the project.

Chapter 2 is discussing about the literature review. It explains the development of photovoltaic technology, the history of solar cell, and overview on the tracker types. Overall, it is about the basic knowledge on solar tracker.

Chapter 3 is discussing about the methodology that involves in designing the project. There are two sections. The first section discusses about the hardware implementation and the second section discuss about software development.

Chapter 4 is discussing about the result and discussion obtain from the testing the project. The result basically on the operation of solar tracker and the prove that 2-axis solar tracker can provide maximum voltage output.

Chapter 5 is discussing about the conclusion of the project. There are future recommendations of the project and the costing and commercialization of the project.

CHAPTER 2

LITERATURE REVIEW

2.1 Solar Power History

Ancient Egyptians built places to live that allowed stored energy from the sun during the day, and a heat release during the night. This kind of architecture heated homes at night while keeping the temperature low during the day. Egyptians also used the sun as part of their mummification process, using the sun to dry dead bodies. The Egyptians used a form of passive solar power.

In 3rd Century B.C., Greek soldiers with the help of Archimedes, focused light on a Roman fleet by using mirrors. The Romans were invading a port city that did not have defenses ready for the attack. The mirrors were used to concentrate the energy of the sun, and cause the fleet's sails to burn. The Romans retreated and the Greeks were able to prevent the invasion. The Greeks used passive solar power.

In 100 A.D. a historical writer by the name of Pliny the Younger built a house in the northern part of Italy that had mica windows in one room. This one particular room demonstrated solar heating in that it's mica windows stored heat, and later gave it off. This room was useful because the added heat it generated lessened the amount of wood that had to be burnt. For the roman bath houses, it a had famous south facing windows that heated the rooms. Other than that, Native Americans also built houses that used passive solar power. Houses were built into the side of cliffs or hills to allow storage of heat during the day, and a release of heat at night.

In 1767, the world's first solar collector was built by Swiss scientist Horace de Saussare. And 1839, a physicist from France, Edmond Becquerei observes the photoelectric effect. It is continue with 1880's, where visible light converting photovoltaic cells made of selenium were built and had 1- 2% efficiency. In 1891 the first commercial solar water heater was patented by the father of American solar energy, Clarence Kemp.

William J. Bailley of the Carnegie Steel Company in 1908 invented a solar collector with copper coils and an insulated box and a book published by the Libbey-Owens-Ford Glass Company in 1947 showcased the fourty-nine greatest American solar architects. By the early 1950's, A process for producing crystalline silicon of high purity was developed, called the Czochralski meter and it’s continue with the Bell Telephone Laboratories in 1954 which is produced a 4% efficiency silicon PV cell, and later accomplished 11% efficiency.

During the mid-1950's, the first solar water heated office building was built by architect Frank Bridgers. In 1958, A small satelitte of US Vanguard was powered by a less than one watt power solar cell. From the 1960's to the present oil prices play an important part of the economics of solar power and other alternative energy forms. In the 1960's cheap imported oil was the main energy competitor to solar power and restricted the overall solar technology market. During 1973 - 1974 the oil embargo allowed opportunity for solar power to flourish. The US Department of Energy funded the Federal Photovoltaic Utilization Program that began installation and testing of over 3,000 PV systems.

In the mid 1980's incentive for business led to around 150 businesses for manufacturing industry with annual sales of $0.8 billion. Gulf War of 1990 renewed interest in solar power as an alternative to oil and petroleum products. Mid-1990's have few tax credits and incentives for solar electric homes or heating systems, yet approximately 1.2 million buildings in the US are solar heated. International markets and foreign investments especially from Germany and Japan took off in 1970, but continue to be major factors in the solar energy market. [1]

2.2 Photovoltaic Technology

Photovoltaic are best known as a method for generating electric power by using solar cells to convert energy from the sun into electricity. The photovoltaic effect refers to photons of light knocking electrons into a higher state of energy to create electricity. The term photovoltaic denotes the unbiased operating mode of a photodiode in which current through the device is entirely due to the transduced light energy. Virtually all photovoltaic devices are some type of photodiode.

Solar cells produce direct current electricity from sun light, which can be used to power equipment or to recharge a battery. The first practical application of photovoltaic was to power orbiting satellites and other spacecraft, but today the majority of photovoltaic modules are used for grid connected power generation. In this case an inverter is required to convert the DC to AC. There is a smaller market for off-grid power for remote dwellings, boats, recreational vehicles, electric cars, roadside emergency telephones, remote sensing, and cathode protection of pipelines.

Cells require protection from the environment and are usually packaged tightly behind a glass sheet. When more power is required than a single cell can deliver, cells are electrically connected together to form photovoltaic modules, or solar panels.

2.3 Solar Panel

In the field of photovoltaic, a photovoltaic module or photovoltaic panel is packaged interconnected assembly of photovoltaic cells, also known as solar cells. An installation of photovoltaic modules or panels is known as a photovoltaic array. Photovoltaic cells typically require protection from the environment. For cost and practicality reasons a number of cells are connected electrically and packaged in a photovoltaic module, while a collection of these modules that are mechanically fastened together, wired, and designed to be a field-installable unit, sometimes with a glass covering and a frame and backing made of metal, plastic or fiberglass, are known as a photovoltaic panel or simply solar panel.

2.4 Solar Tracker

The solar tracker is a device that keeps photovoltaic or photo thermal panel in an optimum position perpendicularly to the solar radiation during daylight hours, can increase the collected energy by up to 50%. Commercially, single-axis and two-axis tracking mechanisms are available. Usually the single-axis tracker follows the sun's East-West movement, while two-axis tracker follows also the sun's changing altitude angle. Sun tracking system have been studied with different application to improve the efficiency of solar system by adding the tracking equipment to these systems through various methods. A tracking system must be able to follow the sun with a certain degree of accuracy, return the collector to its original position at the end of the day and also track during periods of cloud over.

The aim of this solar tracker project is to design a microcontroller operate two-axis Sun Tracker which works efficiently in all weather conditions regardless of presence of clouds for sun tracking systems on the electrical generation of a flat photovoltaic system.

2.5 Polar

Polar trackers have one axis aligned to be roughly parallel to the axis of rotation of the earth around the north and south poles-- hence the name polar. (With telecopes, this is called an equatorial mount.) Single axis tracking is often used when combined with time-of-use metering, since strong afternoon performance is particularly desirable for grid-tied photovoltaic systems, as production at this time will match the peak demand time for summer season air-conditioning. A fixed system oriented to optimize this limited time performance will have a relatively low annual production. The polar axis should be angled towards due north, and the angle between this axis and the vertical should be equal to your latitude. Simple polar trackers with single axis tracking may also have an adjustment along a second axis: the angle of declination. It might be set with manual or automated adjustments, depending on your polar-tracking device. If one is not planning on adjusting this angle of declination at all during the year, it is normally set to zero degrees, facing your panel straight out perpendicular to the polar axis, as that is where the mean path of the sun is found. Occasional or continuous adjustments to the declination compensate for the northward and southward shift in the sun's path through the sky as it moves through the seasons (and around the ecliptic) over the course of the year.

Figure2.1 Polar tracker

2.6 Overview of current driver tracker types

Solar trackers can be divided into three main types depending on the type of drive and sensing or positioning system that they incorporate. Passive trackers use the suns radiation to heat gasses that move the tracker across the sky. Active trackers use electric or hydraulic drives and some type of gearing or actuator to move the tracker. Open loop trackers use no sensing but instead determine the position of the sun through pre recorded data for a particular site.

2.7 Gas Trackers (Passive Trackers)

Passive trackers use a compressed gas fluid as a means of tilting the panel. A canister on the sun side of the tracker is heated causing gas pressure to increase and liquid to be pushed from one side of the tracker to the other. This affects the balance of the tracker and caused it to tilt. This system is very reliable and needs little maintenance. Although reliable and almost maintenance free, the passive gas tracker will very rarely point the solar modules directly towards the sun. This is due to the fact that temperature varies from day to day and the system can not take into account this variable. Overcast days are also a problem when the sun appears and disappears behind clouds causing the gas in the liquid in the holding cylinders to expand and contract resulting in erratic movement of the device. Passive trackers are however an effective and relatively low cost way of increasing the power output of a solar array. The tracker begins the day facing west. As the sun rises in the east, it heats the unshaded west-side canister, forcing liquid into the shaded east-side canister. The liquid that is forced into the east side canister changes the balance of the tracker and it swings to the east. It can take over an hour to accomplish the move from west to east. The heating of the liquid is controlled by the aluminum shadow plates. When one canister is exposed to the sun more than the other, its vapor pressure increases, forcing liquid to the cooler, shaded side. The shifting weight of the liquid causes the rack to rotate until the canisters are equally shaded. The rack completes its daily cycle facing west. It remains in this position overnight until it is "awakened" by the rising sun the following morning. [1]